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L. O. HOWARD, Chief

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THE LESSER CORN STALK-BORER.[1]

By PHILIP LUGINBILL and GEO. G. AINSLIE, *Entomological Assistants, Cereal and Forage Insect Investigations.*

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INTRODUCTION.

Although the lesser corn stalk-borer (*Elasmopalpus lignosellus* Zell.) heretofore has occurred in injurious abundance only in sporadic outbreaks, it now has become an insect of considerable economic importance in the Southern States, since crops grown in the poorest types of soils, or in soils lacking humus, are usually the most seriously affected. The injuries to plants by larvæ of this species sometimes resemble closely those of certain beetle larvæ commonly known as "budworms" (*Diabrotica 12-punctata* Fab.) and it seems probable that injuries frequently attributed to the latter are in reality the work of the lesser corn stalk-borer.

While engaged in other investigations early in the season of 1913 near Columbia, S. C., the senior author was informed by the authorities superintending the State farm near that city that the lesser corn stalk-borer was responsible for considerable damage to their field crops almost every year. Investigations begun immediately were continued through 1914 and 1915. The junior author, while engaged in certain investigations in Florida during the winter of 1913–14, encountered this same species in destructive numbers.

The following paper, therefore, is a compilation of the results obtained from studies made at Columbia, S. C., during the years 1913–1915 by the senior author (27)[2] and at Lakeland, Fla., in 1913–1914, by the junior author.

[1] The authors wish to acknowledge the cooperation of A. H. Beyer and H. L. Dozier in field investigations.

[2] Reference is made by number to "Literature cited," p. 25.

ECONOMIC HISTORY.

Although the lesser corn stalk-borer was originally described by Zeller (3) in 1848, and was known to scientific workers from several parts of the Western Hemisphere, it was not until 1881 that it began to have other than a purely scientific interest. In July, 1881, C. V. Riley, then entomologist of the United States Department of Agriculture, was notified that an insect (later identified as this species) was injuring corn, both old and young, in the vicinity of Augusta, Ga. Steps were taken at once to learn more of the life history and habits of the pest, and agents of the Division of Entomology spent the remainder of the year conducting investigations at these points in order that they might be able to propose remedial or preventive measures. The studies made at that time showed that this insect had not been known as a pest until about 1878, and that during the period 1878–1881 it had become of economic importance in Georgia and South Carolina, specimens being taken even as far north as Chapel Hill, N. C. The life history was partly worked out and published by Dr. Riley (8, 9, 10)[1]; but, as no further complaints were received, the investigation was suspended.

In a discussion of the corn insects of Nebraska, Prof. Lawrence Bruner (14) published a brief account of this species and its work, but did not state that it had been found in Nebraska. In 1884 (11) and again in 1893 (16) Riley listed it as injurious to the stalk of corn.

Not until nearly twenty years after the first recorded damage did it again become the object of special study by entomologists. In 1899 Dr. F. H. Chittenden, of the Bureau of Entomology, received complaints of injury to beans by the insect in Alabama and South Carolina, and also to peanuts in Georgia (19). Specimens of the insects sent to Washington were identified as *Elasmopalpus lignosellus*, and further biological studies were begun. All the available information at this time was brought together, and the results published in Bulletin 23 of the Division of Entomology by Dr. Chittenden (18). A brief note by Dr. Chittenden (21) in Bulletin 40 of the Bureau of Entomology, published in 1903, reported damage to cowpeas in Texas and Virginia, and the Yearbook of the United States Department of Agriculture for 1903 (22) records injury to cowpeas, beans, and soy beans in Texas, Alabama, and Virginia, part of these records undoubtedly being repetitions of those given in Bulletin 40. In 1904 Titus and Pratt (23) listed it as injurious to corn, beans, and peas.

Dr. S. A. Forbes (24) included this species in his monograph of the insects injurious to corn, drawing largely from Riley's account in describing its habits and methods of attack. He added the information, however, that adults had been taken in Illinois in August

[1] See "Literature cited," p. 25.

and September, but the account does not indicate that the species caused damage in the State at that time.

In 1905, as reported in the Yearbook of the United States Department of Agriculture for that year (25), sorghum, cowpeas, and crabgrass were totally destroyed in some fields near Columbia, S. C., and reports of damage were received from other localities in South Carolina and Georgia. On November 4, 1915, the junior author also found at Nashville, Tenn., a small wheat plant killed by a larva which was nearly full grown and which entirely filled the burrow that it had excavated in the stem.

SYSTEMATIC HISTORY AND SYNONYMY.

The lesser corn stalk-borer was first described by Zeller (1) from Brazil, Uruguay (Montevideo), and Colombia, South America, and a single female from "Carolina," U. S. A. In this article, aside from the specific description, Zeller describes three unnamed varieties, basing his descriptions almost entirely on color variations. No further notes are given in this account except from the localities listed. Four years later Blanchard (2) redescribed the species under the name *Elasmopalpus angustellus*, erecting for its reception the genus Elasmopalpus, which recently has been accepted as the proper position for the species. Not until two decades later is there a further reference to the species in the literature, when Zeller (3), in an article dealing with some North American moths, adds somewhat to our knowledge of its seasonal and geographical distribution, recording it from Brazil and Colombia, in South America, and "Carolina" and Texas, in the United States. At the latter place three females were taken, one on July 15 and the other two a month later. He also adds the descriptions of two varieties, *incautella* and *tartarella*, based on color variations. Each of these varieties was described from a single specimen, and both were taken at the same place and on the same date. The species as a whole is extremely variable and Zeller himself in a later publication (7) placed *incautella* as a synonym of *lignosella* though still retaining *tartarella* as a valid variety. Another variety, designated as "variety *B*," was described by Zeller (4) from material collected at Valparaiso, Chile. In 1875, Berg (5), using material taken in Patagonia and elsewhere in southern South America, supplemented Blanchard's description of *E. angustellus*, going into detail, particularly in describing the venation, and two years later, in a further paper on Patagonian insects (6), came to the conclusion that the species he had been considering Blanchard's *angustellus* was Zeller's *lignosella*. Since both the species are genotypes, the reduction of *angustellus* to a synonym of *lignosella* made Elasmopalpus a synonym of Pempelia, where it remained until revived by Hulst in 1890 (13) for this same species. In 1881 Zeller (7) gave some notes on the amount

of variation in the species, basing his remarks on a collection of 25 specimens from Colombia, South America, most of them taken in September and October.

Hulst (12) redescribed this species as new, from Texas, under the name *Dasypyga carbonella*, a mistake which he later rectified in his monograph of the Phycitidae (13), in which he places *carbonella* as a synonym of Zeller's variety *tartarella*. In the same publication he redescribes *lignosellus*, places it in the genus Elasmopalpus for the first time under that name, and gives a bibliography and notes on the distribution and seasonal occurrence.

Ragonot (15) covers much the same ground as several of the previous authors, giving the synonyms, bibliography, and a description of the species and calling attention to its great variability. He also uses the name *major*, the first word of Zeller's description, for the variety *B* mentioned above and lists it as a variety of the species *lignosellus*. Smith (17 and 26) records the species from New York, and Dyar (20) lists it with its synonyms in his catalogue of the Lepidoptera of North America, giving the distribution as the Atlantic States and South America.

The junior author has gone carefully over all the descriptions given by the various authors mentioned above, examining the specimens in the United States National Museum, and has come to the conclusion that the use of all varietal names in this species may well be discontinued. The varieties that have been described are not constant in any respect either as to size, geographical distribution, or seasonal occurrence, and apparently they indicate merely individual aberrations in color, size, or markings. The synonymy, then, stands as follows:

Pempelia lignosella Zeller (1),
Elasmopalpus angustellus Blanchard (2),
Pempelia lignosella tartarella Zeller (3),
Pempelia lignosella incautella Zeller (3),
Dasypyga carbonella Hulst (12),
Elasmopalpus lignosellus (Zeller) Hulst (13),
Elasmopalpus lignosellus incautellus (Zeller) Hulst (13),
Elasmopalpus lignosellus tartarellus (Zeller) Hulst (13).

GEOGRAPHICAL DISTRIBUTION.

This species is limited in its occurrence to the Western Hemisphere. It occurs practically throughout South America, having been reported from widely separated localities in all parts of that continent. The list as given by Hulst includes Venezuela, Colombia, Brazil, Argentina (Buenos Aires), Chile, and "Patagonia." In North America (fig. 1), while its range is not so great, it may be said to occur over the entire southern half of the United States. It has been most

commonly reported from the States bordering the Gulf of Mexico and the southern Atlantic coast. It has been encountered causing injury in Arizona. Dr. Forbes reports it as having been taken at various points in southern Illinois. There is a specimen in the National Museum rather indefinitely labeled "Iowa." The late Prof. F. M. Webster observed some of the moths years ago at Lafayette, Ind. In addition to the one mentioned above there are specimens in the National Museum bearing locality labels indicating that the moths have been taken at Cohasset, Mass.; Clemson College, S. C.; Miami, Palm Beach, and Lakeland, Fla.; New Orleans, La.; Dallas, Brownsville, Sabinal, Kerrville, Victoria, and Burnet County, Tex.; and San Diego, Cal. John B. Smith, in his List of the Insects of New Jersey, records it from Newark and Montclair and states that it will

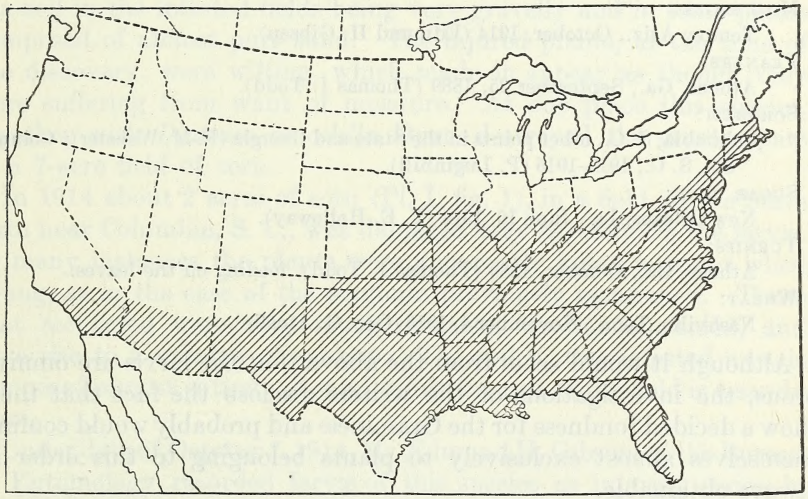


FIG. 1.—Map showing present known distribution of the lesser corn stalk-borer (*Elasmopalpus lignosellus*) in the United States. (Original.)

be found throughout the State. It undoubtedly occurs throughout Mexico and has been reported from the Bahama Islands.

FOOD PLANTS.

The following is a list of food plants upon which the larvæ of this species have been found to feed, given here with locality, date, and collector or observer:

BEANS:

Auburn, Ala., August 16, 1889 (F. S. Earle); Charleston, S. C., September 27, 1889 (H. M. Simmons).

CORN (*Zea mays*):

Augusta, Ga., 1881 (C. V. Riley); Illinois, 1905 (S. A. Forbes); Lakeland, Fla., April 25, 1913 (Geo. G. Ainslie); Columbia, S. C., 1913–1914 (P. Luginbill); Tempe, Ariz., October, 1914 (Edmund H. Gibson).

COWPEAS:

Victoria, Tex., August 30, 1902 (W. D. Hunter); Fredericksburg, Va., September 2, 1902 (G. W. Koiner); Columbia, S. C., and other points in the State, and Georgia, 1905 (F. M. Webster); Columbia, S. C., 1914 (P. Luginbill); Gainesville, Fla., July and August, 1916 (R. N. Wilson and H. L. Dozier); Boca Grande, Fla., June 29, 1916 (H. L. Dozier); Arcadia, Fla., June and July, 1916 (Joseph Crews).

CHUFA (*Cyperus esculentus*):

Arcadia, Fla., June and July, 1916 (Joseph Crews).

CRAB GRASS (*Eleusine indica*):

Columbia, S. C., other points in the State and Georgia, 1905 (F. M. Webster); Columbia, S. C., August 27, 1913 (P. Luginbill).

JAPANESE CANE:

Arcadia, Fla., June and July, 1916 (Joseph Crews).

JOHNSON GRASS:

Tempe, Ariz., November 3, 1914 (Edmund H. Gibson).

MILO MAIZE:

Tempe, Ariz., October, 1914 (Edmund H. Gibson).

PEANUTS:

Athens, Ga., September 25, 1889 (Thomas I. Todd).

SORGHUM:

Columbia, S. C., other points in the State and Georgia (F. M. Webster); Columbia, S. C., 1913–1915 (P. Luginbill).

SUGAR CANE:

New Orleans, La., June 16, 1914 (T. E. Holloway).

TURNIPS:

Athens, Ga., October, 1889 (Thomas I. Todd), feeding on the leaves.

WHEAT:

Nashville, Tenn., November 4, 1915 (Geo. G. Ainslie).

Although it would seem from the above that the larvæ are omnivorous, the investigations of the writers disclose the fact that they show a decided fondness for the Gramineæ and probably would confine themselves almost exclusively to plants belonging to this order if always obtainable.

RECENT INJURIES.

This species is particularly injurious because it shows a decided fondness for attacking plants growing in sandy soil. Soil of this type generally is deficient in fertilizing elements and also suffers very quickly from drought. Consequently plants growing in such soil are not as thrifty and vigorous as those growing in loamy soils, and when attacked they lack vitality to counteract the injury and suffer more than do those in soils of more favorable nature. It frequently occurs that only certain portions of the field are of this sandy type and in such cases infestation is confined to the sandy areas, it often being difficult to find larvæ in the rest of the field.

During the summer of 1913 about 2 acres of sorghum in a field on the State farm near Columbia, S. C., was practically laid waste by the ravages of this species. The soil in this area was almost pure sand, while the rest of the field was sandy loam. In many instances,

as shown in Plate I, figure 2, no trace of plants could be found when the photograph was taken, the larvæ having killed them outright when young. Those that did survive were much dwarfed and rendered practically worthless, and in most instances were devoid of central stems.

In the latter part of April, 1913, fields of small corn near Lakeland, Fla., were being attacked and ruined by these larvæ, about 10 per cent of the plants exhibiting evidences of injury at this time. The plants continued to die for about 10 days, at the end of which time in some portions of the fields fully 90 per cent were dead and the stand everywhere was poor. The parts of the fields most lacking in humus suffered the greatest injury. During the same year considerable damage was done to cowpeas in fields near Columbia, S. C., the soil in the infested fields being very gravelly and in some places composed of almost pure sand. The injured plants, at the time of the discovery, were wilting, which made it appear as though they were suffering from want of moisture. At one place this species, together with *Diatraea zeacolella* Dyar, destroyed the greater part of a 7-acre field of corn.

In 1914 about 2 acres of corn (Pl. I, fig. 1), in a field on the State farm near Columbia, S. C., was damaged very severely by the larvæ. In many instances the plants were apparently killed outright when young, as in the case of the sorghum previously mentioned. Those that recovered were very much dwarfed, became one-sided, and gave rise to a number of suckers. The soil in this infested area is composed almost entirely of sand, while the rest of the field is a sandy loam.

Under date of October 7, 1914, Mr. Edmund H. Gibson, of the Bureau of Entomology, recorded larvæ of this species as injuring seriously corn in laboratory plats at Tempe, Ariz. Pulling up 15 stunted and withered corn plants, he found the larva in every stalk. Later in the month the larvæ were more abundant on corn and were also taken from sorghum sprouts and milo maize. On November 3 of the same year larvæ were collected from Johnson grass growing in a barley field, and about 70 per cent of the grass was injured, although the barley showed no evidence of injury.

During July and August, 1916, about 2 acres of sorghum in a field on the State farm near Columbia, S. C., was again practically laid waste by the ravages of these larvæ. The soil in this area also was of a sandy nature. Some of the badly infested plants were from 1 to 2 feet tall and without a central stem, as late as September, whereas plants uninfested were from 5 to 8 feet tall and in head.

Under date of August 19, 1916, Mr. H. L. Dozier, of the Florida Agricultural Experiment Station, informed the senior author that larvæ of this species were damaging cowpeas in plats on the station grounds.

The soil in these plats was of a sandy nature. He further stated that a report was received from Boca Grande, Fla., that 2 of 18 acres of cowpeas had been destroyed by this pest. Mr. R. N. Wilson, of the Bureau of Entomology, who was instructed to investigate this infestation more fully, confirmed Mr. Dozier's statement, young plants being injured by the larvæ boring into and upward in the stems, while in older plants the stems were girdled at or slightly below the ground. The result in both cases was that the injured plants wilted and died, although it was noted that in exceptional cases the plants, being vigorous, overcame the injury. Mr. Wilson further submitted a letter which had been received from Mr. Joseph Crews, farm demonstrator at Arcadia, Fla., stating that the "worms" injured cowpeas, Japanese cane, corn, and chufa. Cowpeas were damaged to some extent in the stiff black soil, but more serious damage was done in the sandy soil. This soil had all been well limed and heavily fertilized. Damage was done to Japanese cane planted in an old piece of land which was cleared years ago but had not been under cultivation for a number of years until the present. At least 90 per cent of the crop was damaged and the crop lost about 50 per cent in value.

While the increasing number of records of damage by this insect in the last few years is due in part to the fact that injury by it is more likely to be reported now than was the case years ago, it is also probable that the species is slowly modifying its habits to correspond with modern methods of agriculture and that, in the future, occasional outbreaks, perhaps more severe than any yet recorded, may be expected unless means are taken to check them in advance.

DESCRIPTIONS.[1]

THE EGG.

The egg (fig. 2) is ovate, circular in cross section, 0.67 mm. in length and 0.46 mm. in diameter; greenish white when first deposited, pinkish in from 18 to 24 hours, an approximate Alizar crimson with a tinge of yellow at end of incubation period; strongly iridescent. Exochorion sculptured with shallow pits pentagonal to polygonal in outline. Endochorion apparently smooth.

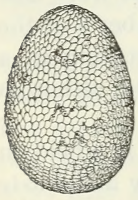


FIG. 2.—The lesser corn stalk-borer: Egg. Greatly enlarged. (Original.)

LARVAL INSTARS.

First instar.—Length 1.7 mm. Head slightly bilobed, flattened, highly polished dark brown, width 0.23 mm., about as high as wide; clypeus triangular, 0.11 mm. high. Paraclypeal pieces not perceptible, region dusky; labrum pale, tips of mandibles reddish brown, not projecting; setæ 0.11 mm. long; antennæ pale, moderate. Cervical shield almost straight in front, much rounded behind, one not quite as wide as the head. Prespiracular tubercle bears 2 setæ, the upper of the two being the shorter; subventrical tubercle also bears 2 setæ, the cephalad one being

[1] Descriptions by senior author. Measurements of all stages made from alcoholic material. That given for the length of larva in stage 5 is a little low on account of insufficient material on hand for a better average.

FIG. 1.—CORN INJURED BY THE LESSER CORN STALK-BORER IN A FIELD NEAR COLUMBIA, S. C., IN 1914. (ORIGINAL.)

FIG. 2.—INJURY TO SORGHUM BY THE LESSER CORN STALK-BORER NEAR COLUMBIA, S. C., IN 1913. (ORIGINAL.)

DAMAGE TO CORN AND SORGHUM BY THE LESSER CORN STALK-BORER (ELASMOPALPUS LIGNOSELLUS).

the shorter. Anal plate somewhat triangular, dusky. Body pale yellowish to yellowish green; posterior portion of each segment bright red to reddish brown on dorsum; whole dorsum of joint 5 of this color. These areas are joined by faint stripes, some little distance apart, of the same color, giving the larva a longitudinally striped as well as transversely banded appearance. Segments all slightly swollen, except last. Tubercles small; "iv–v" coalescent on joints 5–13, inclusive, below spiracle on joint 5, laterad and slightly cephalad of spiracle on joints 6–12, inclusive, directly laterad of "iii" in joint 13. Setæ "iib" of joint 3 and "iii" of joint 12 0.25 mm. long, about twice as long as others. Abdominal segments except terminal crossed transversely through the middle by shallow grooves on dorsum. Thoracic feet pale, though somewhat dusky; abdominal prolegs all whitish.

Second instar.—Length 2.7 mm. Head slightly bilobed, flattened, highly polished, blackish brown, width 0.29 mm., clypeus 0.14 mm. high. Cervical shield concolorous with head, 0.26 mm. in width. Anal plate dusky. Body pale yellowish; transverse bands and stripes adjoining as in preceding stage. Tubercles "iib" of joint 3 and "iii" of joint 12 large, each supplied with a long seta as before; subprimaries present. Thoracic feet pale to dusky; abdominal prolegs same as venter of body, pale yellowish.

Third instar.—Length 5.7 mm. Head as in second instar except trifle paler, width 0.44 mm., a little wider than high; clypeus 0.20 mm. high; labrum pale amber, mandibles dark amber, almost black at tips; antennæ pale amber at tips, otherwise pale whitish. Cervical shield large, darker than head, the anterior border extending somewhat over the head lobes, wider than head, width 0.54 mm., length 0.30 mm., corneous, polished. Body pale greenish white to pale yellowish green; transverse bands and connecting stripes reddish brown to brown, sometimes only greenish white between the stripes; tapering posteriorly. Thoracic legs dusky; abdominal prolegs pale yellowish green, same as venter.

Fourth instar.—Length 6.9 mm. Head slightly bilobed, polished dark brown, 0.61 mm., about two-thirds as high as wide; clypeus 0.25 mm. high; around base of spines pale. Cervical shield concolorous with head, width 0.89 mm., length 0.45 mm. Prespiracular tubercle large, somewhat corneous, dusky; subventrical tubercle also dusky, normal. Body as in preceding stage except that venter is taking on deep green color; greenish white more conspicuous and breaking into the transverse bands, very deeply in some segments; stripes joining transverse bands wider than before. Thoracic legs and abdominal prolegs as before.

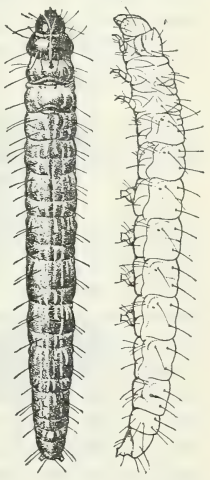


FIG. 3.—The lesser corn stalk-borer: Larva. Greatly enlarged. (Original.)

Fifth instar.—Length 8.8 mm. Head bilobed and polished as before, very dark brown black, width 0.89 mm., clypeus 0.32 mm. high, the paraclypeal pieces distinct, the sutures almost touching the beginning of the intersection point of the lobes on the vertex, whitish; labrum pale amber, mandibles amber, very dark at tips. Cervical shield darker than head, 1.02 mm. wide, 0.62 mm. long; on the meson is a pale stripe extending longitudinally from the posterior border to a point almost across the shield. Body as in preceding stage except that transverse bands are now at a point of being broken up, giving way to pale yellowish white color of the dorsum, the dark color being now confined chiefly to the longitudinal stripes, now almost continuous over the body but very irregular; in some specimens there is a whitish patch, ellipsoidal in outline, on the dorsum of joints 3 and 4; venter tinged with pale reddish. Thoracic legs and abdominal prolegs as in preceding stage.

Sixth instar.—Length 16.2 mm. (fig. 3). Head slightly bilobed, somewhat flattened, dark brownish black, highly polished, width 1.11 mm. Clypeus triangular, somewhat

pale in the upper angle, extending over two-thirds of height of head (0.43 mm.). Paraclypeal pieces prominent, sutures converging at the beginning of intersection point of head lobes on vertex; setæ pale, stiff, pale around base; proximal parts of antennæ pale whitish, distal amber; labrum pale amber, width 0.32 mm.; mandibles dark red, black at tips. Cervical shield dark brown, width 1.49 mm., length 0.93 mm.; pale line on meson extending across the shield, coming to a point before; extending over head to intersection of lobes. Body Nile green, prevailing color on the dorsum greenish white, which almost breaks up completely the dark brown transverse bands; longitudinal stripes conspicuous, dark brown, somewhat broken. Tubercles "ia" and "ib" of joint 3 small, setæ short, "iia" and "iib" small, seta long; "ia" and "ib" of joint 4, small, seta short, "iia" and "iib" small, seta long, caudad of latter is dusky patch, somewhat polished; on joints 3 and 4 "iii" is caudo-laterad of "iib," distant, "iv" is cephalad and slightly laterad of "iii," distant, "v" cephalo-laterad of "iv," well separated; "iv–v" is coalescent on joints 5 to 13, inclusive, arrangement as before; on joint 13 "vi" is near "v"; on joints 12 and 13 "ii" is much nearer meson than "i," on joint 11 "i" and "ii" arranged in form of square. All segments slightly swollen except last two; transverse grooves prominent. Thoracic legs dusky; abdominal prolegs pale.

FIG. 4.—The lesser corn stalk-borer: Pupa. Greatly enlarged. (Original.)

PUPA.

The pupa (fig. 4) when freshly formed is pale green, yellowish on abdominal segments; later brown and just preceding emergence of adult uniform black; lustrous; delicate; length 8.1 mm., width 2 mm. Spiracles ellipsoidal, prominent, except on joint 12, obsolete. Dorsum of terminal segment has slight elevation or hump which slopes abruptly posteriorly and forms the obtuse tip. Anterior portion of this elevation corneous, rugose, and black. At tip is a row of six hooked spines arranged transversely, about 0.17 mm. in length. Tip of the male pupa is rounded, that of the female pupa irregular. Other sexual differences in pupal stage shown in figure 5, *a* and *b*. Abdominal segments 1 to 7, inclusive, densely and finely pitted on dorsum, very abundant and scattered almost over whole surface of first four segments, scant and restricted to anterior border of last three.

COCOON.

The cocoon is cylindrical, compact, 15.9 mm. in length, and 5.9 mm. in diameter, oval in outline, frequently supplied with exit tube at an angle of about 145°; 23.9 to 30 mm. in length and 4 mm. in diameter; lined throughout on inside very smoothly with silk and covered without with sand and dirt particles. (Pl. II, figs. 3 and 4.)

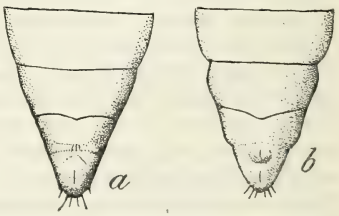


FIG. 5.—The lesser corn stalk-borer. Comparison of terminal segments of male and female pupæ showing sexual differences: *a*, Female; *b*, male. Greatly enlarged. (Original.)

ADULT.[1]

Expanse 17–22 mm. Head brown to blackish. Labial palpi erect, not recurved; somewhat longer in the male than in the female and more slender, heavily scaled, lying close together on the shining crest which is hollowed out for them; somewhat clavate toward the tip, end member very short, about one-eighth the middle; groove for the pale papillary tufts reaching almost to the apex and very deeply impressed. Basal segments pale gray outside, within bearing a longitudinal white stripe which broadens somewhat at the end of

[1] Compiled from descriptions of Zeller and Hulst by the junior author.

the second and beginning of the last segment. Maxillary palpi pencil-tufted. Proboscis long, strong, scaled. Ocelli present. Antennæ brownish, simple, bent and expanded above the base, with a heavy tuft of scales in the bend in the male; in the female more slender and without the tuft. (Fig. 6.)

Thorax ochre-brown to blackish. Legs brownish gray, darker on the outside; tarsal segments bright yellow. Forewings very narrow, much elongated, 8–9 mm. long; distal margin oblique, posterior margin waved; in male (fig. 6, *a*) ochre-brownish on posterior margin from base out, with a poorly defined median stripe of ochre-brownish reaching almost to distal margin; remainder of margin varying from a narrow edging of brown to a complete covering of wing with blackish to plumbago; disk yellow-ochreous to reddish; on subdorsal vein slightly before middle where posterior margin begins to darken lies a dense brown dot marking position of first transverse line; diagonally outwards above it upon median vein is a smaller dot and beyond a more prominent one on cross vein; both lie in the bright median space but close to yellowish-brown shading of anterior margin; distal margin marked by row of black confluent dots within which is indistinct grayish stripe dusted with whitish atoms; within this in the dark color of surface appears beginning of second cross line very close to distal

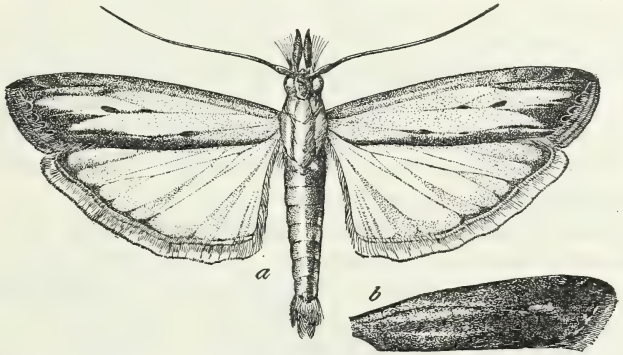


FIG. 6.—The lesser corn stalk-borer: *a*, Male moth; *b*, forewing of female moth. Greatly enlarged. (Original.)

margin and most apparent on anterior margin; fringes brownish gray, beneath shining brownish gray; in the female (fig. 6, *b*) markings are the same but generally darker than in male; dot on the subdorsal vein enlarged but not prominent, dot on cross vein somewhat more distinct. Hind wings white, pellucid, somewhat grayish or brownish along anterior and distal margins and at apex shading back into the wing for a greater or less width; fringes whitish, brownish toward apex and bearing a faint yellowish line paralleling margin; beneath along anterior margin browner than above. Venation: Forewings, eleven veins, 4 and 5 separate, 10 separate; hind wings, 2 more or less distant from angle, 4 and 5 stemmed, 6, 7, and 8 stemmed, cell rather short.

Abdomen yellowish to fuscous, darker in female; terminal tuft of male yellowish at the end and in the middle, gray laterally, darkening toward end; of female yellowish. Male genitalia: Uncus longer, more slender than usual in related genera, bifid at base; these parts arched; the spine long, harpes broad with long hairs along upper edge forming somewhat of an anal tuft; a strong bent spine at base; lower plate conical, within entrance a long, slender, bent spine; last segment of abdomen beneath with two tufts of hair.

SEASONAL HISTORY.

OVIPOSITION.

Eggs of this species have not been found in the field; but, judging from the results obtained from rearing, they are probably deposited on the stems of plants, in the axils of the leaves, or on the ground at or near the bases of the stalks. The larvæ upon hatching crawl to the stalks and begin feeding.

In rearing cages, the eggs are deposited generally on the cheesecloth which covers the lantern globe. Sometimes, however, they are deposited on bits of grass leaves or stems, pieces of cloth or other loose material placed in the bottom of the cage, on the stem of grass placed in the cage as food or, not at all infrequently, upon the cotton which holds the sprig of grass in place. Most of the eggs deposited on the cloth top are pushed through the mesh of the cloth by the female and are found on the upper side of the cloth, appearing as though they were deposited from without. Eggs are placed singly as a rule, though sometimes two or three *en masse* may be found glued securely together. In such cases they lose their individual rotundity and flatten out somewhat at points at attachment. A mucilaginous substance secreted by the female, which hardens after exposure to the air, glues the eggs firmly to the object.

The females begin to oviposit shortly after dusk and continue until the early hours of the morning. The majority of the eggs are deposited during the forepart of the night and it is probable that all of them are laid at this time under field conditions. No eggs are deposited during the day or in bright light at night. Oviposition will take place, however, in diffused light, although not as many eggs will be deposited as in total darkness.

EFFECT OF TEMPERATURE ON OVIPOSITION.

Oviposition did not take place when the temperature fell much below 80° F. Two cages containing a number of females and males were kept under normal conditions; three others, also supplied with a number of moths of both sexes, were kept in a room the temperature of which rose to somewhere between 80 and 90° F. during the day and fell gradually, reaching approximately 80° F. by early evening and practically normal by morning, as the windows were kept open all night. Eggs were obtained in all the cages kept in the room, all of them being deposited during the early part of the evening. No eggs were obtained in the cages kept under normal conditions. The same type of cage was used in both cases, consisting of a flowerpot surmounted by an ordinary lantern globe, the top of which was closed with a bit of cheesecloth held in place by a rubber band.

TABLE I.—*Incubation records of eggs of Elasmopalpus lignosellus obtained from one female at Columbia, S. C., 1913.*

Deposited.		Hatched.		Incubation period.
Date.	Number of eggs.	Date.	Number of eggs.	
				Days.
Aug. 28	50	Aug. 31	50	3
Aug. 29	57	Sept. 1	57	3
Aug. 30	40	Sept. 2	40	3
Aug. 31	49	Sept. 3	49	3
Sept. 1	36	Sept. 4	36	3
Sept. 2	30	Sept. 5	30	3
Sept. 3	26	Sept. 7	26	4
Sept. 4	17	Sept. 8	17	4
Sept. 5	7	Sept. 9	7	4
Sept. 6	3	Sept. 9	3	3
Sept. 7	4			
Total	319			
Average				3.16

TABLE II.—*Incubation period of eggs of Elasmopalpus lignosellus deposited during 1914 and 1915 at Columbia, S. C.*

Deposited.		Hatched.		Egg stage.
Date.	Number of eggs.	Date.	Number of eggs.	
				Hours.
Aug. 31, 10 p. m. to 11 p. m.	1	Sept. 5, 7 p. m.	1	116–117
Aug. 31, 11 p. m. to 12 m.	14	Sept. 5, 8.30 p. m.	12	116.5–117.5
		Sept. 6, 8 a. m.	2	128.5–129.5
Sept. 1, 7 p. m.	1	Sept. 6, 9 a. m.	1	110
Sept. 1, 12 m.	30	Sept. 5, 8.30 p. m.	14	92.5
		Sept. 6, 8 p. m.	16	116
Sept. 9, 8 p. m.	2	Sept. 12, 10 p. m.	2	74
Sept. 9, 8 p. m. to 10 p. m.	23	Sept. 12, 10 p. m.	21	70–72
		Sept. 12, 12 m.	2	74–76
Sept. 2, 9 p. m.	66	Sept. 6, 9 a. m.	66	84
				Days.
Sept. 5	11	Sept. 9	11	4
Sept. 4	36	Sept. 8	36	4
Sept. 10	53	Sept. 13	53	3
Sept. 13	24	Sept. 18	24	5
June 23	27	June 26	27	3

LENGTH OF INCUBATION PERIOD.

From Tables I and II it will be seen that the egg stage varies from three days in the summer time to five days in early fall, being influenced greatly by temperature conditions. In late fall, eggs were obtained that required from six to eight days to hatch.

TABLE III.—*Number of eggs deposited by 1 female of Elasmopalpus lignosellus in 1 day and during life, at Columbia, S. C., 1915.*

Cage 15–1112.		Cage 15–1113.		Cage 15–1114.	
Date of oviposition.	Number of eggs.	Date of oviposition.	Number of eggs.	Date of oviposition.	Number of eggs.
June 15	73	Sept. 2–3	25	Aug. 31	15
June 16	11	Sept. 4	36	Sept. 1	31
June 17	73	Sept. 5	11	Sept. 2–3	38
June 19	61	Sept. 6	5	Sept. 4–5	19
June 21	27	Sept. 8	9	Sept. (?)	60
June 22	39	Sept. 9	7	Sept. 9	22
June 23	27	Sept. (?)	20	Sept. 10	3
June 24	15	Sept. 10	9	Sept. 11	3
June 25	6	Sept. 11	12	Sept. 12	1
June 26	4				
June 28	6				
Total	342		134		192
Average per day	24.43		(?)		(?)

Cage 15–1115.		Cage 15–1116.		Cage 15–1117.	
Date of oviposition.	Number of eggs.	Date of oviposition.	Number of eggs.	Date of oviposition.	Number of eggs.
Sept. 10	53	Sept. 8	56	Sept. 13	24
Sept. 11	56	Sept. 9	35	Sept. 14	55
Sept. 12	38	Sept. 10	34	Sept. 15	12
Sept. 13	34	Sept. 11	33		
Sept. 14	1	Sept. 12	28		
Sept. 15	9	Sept. 14	8		
Sept. 16	2				
Sept. 17	4				
Total	197		194		91
Average per day	24.63		27.71		30.30

NUMBER OF EGGS DEPOSITED BY ONE INDIVIDUAL.

The number of eggs deposited by one individual under laboratory conditions varies (as will be seen by referring to Table III) from 91 to 342, with an average of 190. The small number deposited in Cage 15–1117 was probably due to premature death of the female.

The number of eggs deposited by one individual in any one day varies from 1 to 73. The daily average computed from the daily average of the four cages in Table III is about 26.77 eggs.

In two other experiments conducted in July, 1914, 188 eggs were obtained in one cage and 311 eggs in the other.

PROCESS OF HATCHING.

Shortly before the larva is ready to emerge it can be seen very distinctly through the semitransparent shell. The brown-black head and the pinkish markings on the segments especially are conspicuous. The larva occupies a curled position inside of the shell, with its head resting on the ultimate and penultimate segments of the body. Just preceding emergence a wavelike rhythmic motion is seen, starting at the head and continuing from segment to segment slowly to the end of the body, after which the larva moves its head about and with its mandibles makes an incision large enough for it to pass through. This takes about five minutes. The larva then usually rests a few minutes, after which it begins to draw itself out of the shell.

NUMBER AND LENGTH OF INSTARS AND LENGTH OF LARVAL LIFE.

The number of instars and their length, as well as the total length of the larval life, are extremely variable, as will be noted by referring to Tables IV, V, and VI. These variations are due in part to differences of temperature. During the summer months the larvæ may molt four or five times and in fall five or six, making from five to six instars for the former and six to seven for the latter. The seventh instar in such instance resembles the sixth in color pattern and size. The second instar and sometimes the third is somewhat longer than the first during the summer months. In fall, however, the first instar is longer than any of the others, except the last one, or the one just preceding pupation, which is generally also the longest during the summer months.

The length of the life of the larva is somewhat dependent upon the number of instars. The larger the number of instars the larva undergoes, the longer the period it will take in reaching maturity, as is brought out by comparing the averages of the instars in Tables IV, V, and VI. In Table IV the larvæ having five instars reached maturity in 374.5 hours, while those having six instars reached maturity in 406.33 hours. In Table V those having five instars reached maturity in 397 hours, as compared to 453 hours for the six-instar larvæ. In Table VI the six-instar larvæ required 842 hours while the seven-instar larvæ required 906 hours to reach maturity.

The larvæ may reach maturity in the short period of 13.8 days, but generally in about 16.8+ days, during the summer months. However, one larva required as many as 20.8+ days to reach maturity. In fall, when temperatures are low, this period is considerably lengthened, varying from a minimum of 22.0+ to a maximum of 41.6 days.

TABLE IV.—*Number of instars, their length, and length of larval life of Elasmopalpus lignosellus during the months of June and July, 1914, at Columbia, S. C.*

Number of tube.	First instar.	Second instar.	Third instar.	Fourth instar.	Fifth instar.	Sixth instar.	Length of larval life.
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
1	56	60	48	96	144	.....	404
2	44	36	48	60	144	.....	332
3	44	36	60	48	72	144	404
4	44	36	48	60	84	144	416
5	44	36	48	60	48	172	408
6	56	60	48	72	172	.....	408
7	44	36	48	84	144	.....	356
8	44	36	60	72	84	108	404
9	44	36	48	84	72	120	404
10	44	36	48	60	84	132	404
11	44	48	36	60	72	144	404
12	44	48	36	60	84	156	428
13	44	48	36	60	84	156	428
14	44	36	48	60	48	120	356
15	44	36	60	72	144	.....	356
16	44	36	60	72	120	.....	332
17	44	36	48	60	84	144	416
18	44	36	60	72	72	120	404
19	56	48	84	84	180	.....	452
20	44	36	48	84	144	.....	356
Average	45.8	40.8	50.5	69	104	138.3	393.6

TABLE V.—*Number of instars, their length, and length of larval life of Elasmopalpus lignosellus, during the month of August, 1915, at Columbia, S. C.*

Number of tube.	First instar.	Second instar.	Third instar.	Fourth instar.	Fifth instar.	Sixth instar.	Length of larval life.
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
15-771	69	60	60	72	120	.....	381
15-773	81	36	72	72	144	.....	405
15-774	45	72	48	72	120	.....	357
15-775	69	72	72	48	72	96	429
15-776	69	72	72	48	72	120	453
15-777	69	60	60	72	72	120	453
15-786	69	72	48	72	24	168	453
15-788	81	60	72	72	120	.....	405
15-790	69	60	60	72	120	.....	381
15-791	69	72	48	72	72	144	477
15-795	93	60	60	72	120	.....	405
15-797	69	72	48	72	120	.....	381
15-925	69	48	48	72	120	.....	357
15-926	81	48	60	72	168	.....	429
15-927	69	48	48	72	144	.....	381
15-929	69	48	72	72	120	.....	381
15-933	81	60	48	72	240	.....	501
Average	66	59.6	58.6	69	115.8	127.6	413.5

TABLE VI.—*Number of instars, their length, and length of larval life of Elasmopalpus lignosellus, during the months of September and October, 1914, at Columbia, S. C.*

Number of tube.	First instar.	Second instar.	Third instar.	Fourth instar.	Fifth instar.	Sixth instar.	Seventh instar.	Length of larval life.
	Hours.	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*	*Hours.*
1	209	72	108	156	120	108	144	927
2	153	84	72	96	192	120	168	885
3	165	108	204	132	48	144	.....	799
4	165	84	252	96	72	288	.....	957
5	117	156	108	84	84	288	.....	837
6	129	120	144	72	96	216	.....	777
Average	156.3	104	148	106	102	194	156	863.7

DURATION OF THE MOLTING PERIOD.

During the summer months the time required for the larvæ to molt varies from 12 to 24 hours in all the instars and during the fall from 12 to 26 hours and sometimes 48 hours. The majority of the larvæ in fall require only 24 hours. Generally a longer time is required in the last instars than in the first ones.

DESCRIPTION OF ECDYSIS.

The larva when about to cast its skin becomes pale, sluggish, and usually remains motionless in tunnel or tube unless disturbed, and even then it is not as active as normally. The first real indication that molting has commenced is the appearance of a pale whitish patch in the region of the neck. This patch is the outer conjunctival layer which, having been loosened, is being unfolded to accommodate the growing larva. This patch becomes more and more evident as molting progresses. The eyes at this time can be seen through the semitransparent conjunctival layer, appearing a little distance back of the head mask. The outer layer of the cuticle, having been loosened throughout, ruptures immediately back of the head mask, first on the venter, then rapidly extending laterally and dorsally. The larva with wavelike rhythmic motions gradually draws itself out of the old cuticular layer. Just at the point when the last joint is being extricated the larva bears down with the head and frees itself from the mask.

FEEDING HABITS OF THE LARVA.

The larva of the species, as its common name would indicate, has a habit of boring or tunneling into the stems of growing plants (Pl. III, fig. 3) and feeding within. This manner of feeding is especially characteristic where young corn and sorghum plants are attacked. The larvæ in such cases tunnel into the stalks at or slightly below the surface of the ground, through and sometimes up the heart for a distance varying from 1 to 2 inches. The bud leaves of such affected plants die, having been severed from the main plant; Plate III, figure 2, shows the appearance of such a plant. The bud leaves dry up and wither away. Some of the plants may survive, but such plants remain in a dwarfed condition or become deformed and one sided.

Injury to corn in this manner resembles closely the work of the southern corn rootworm (*Diabrotica 12-punctata* Oliv.); however, *E. lignosellus* is an upland species, being found only in the driest of soils, while the corn rootworm breeds generally in the moist lowlands.

In older corn and sorghum, as well as in cowpeas, the damage consists primarily in the girdling of the stems at or slightly below the surface of the ground, but the larvæ also tunnel into the stems,

thereby weakening them to such an extent that very little pressure is required to break them off, and frequently infested plants break off at this point when attempts are made to pull them up.

Cowpea plants have been found almost completely cut in two, at a point near or slightly below the surface of the ground, by the larvæ girdling the stem, while in other cases the larvæ were found tunneling into the stems as in the case of corn and sorghum.[1]

It is seldom that larvæ are found in the tunnels of the plants upon which they feed, but more often in specially constructed tubes which lead away from the entrance to the tunnel in the stalk, lying even with or slightly beneath the surface of the ground or sometimes curved around the stems. Plate II, figures 1 and 2, shows the tubes attached to the stems at the entrance to tunnels. These tubes are often 2 inches or more in length and have a number of side galleries or chambers (Pl. III, fig. 1). They are composed of particles of sand and dried excrement of the larvæ spun together with silk. They are generally rather delicate and fall to pieces unless handled with great care. The larvæ apparently use these tubes as a means of retreat when disturbed while feeding.

In young corn and sorghum not more than two larvæ have been found feeding on one plant, each from within a separate tube, and in cowpea plants never more than one. In older corn and sorghum as many as 6 larvæ have been found feeding at one time on the same plant and 13 cocoons taken from the surrounding soil. Dr. Forbes (24) reports that as many as 13 larvæ have been found feeding on a single corn plant.

In our rearing cages larvæ were fed cowpea leaves in test tubes and jelly glasess. During the first and second instars the larvæ have a habit of partially skeletonizing the leaves, devouring the epidermis of one side and the mesophyll, leaving the epidermis of the other side intact. They construct on the leaf delicate tubelike coverings made up of dried excrement spun with silk and feed from under this covering. After the second instar the larvæ begin to eat the leaves, perforating them and devouring all except the midveins. They persist in skeletonizing the leaves even when almost mature, and this is especially noticeable when given leaves that are somewhat tough or whose tissues have hardened. The boring habit (Pl. III, fig. 3), so characteristic of the work of the larvæ in stalks, was demonstrated even while the larvæ were feeding upon leaves, the larvæ even in their earlier stages boring into the larger veins of the leaves and petioles and constructing tubes leading away from the entrance to the tunnel. This habit was discontinued in the last stages, the larvæ feeding as do those of most Lepidoptera.

[1] Dr. Chittenden (22) makes mention of this method of feeding and illustrates it with a figure.

ACTIVITY OF THE LARVA.

The larvæ of this species, while very active, even when quite young, are much more so as they become older. They have a habit, when disturbed, of skipping and jumping about, an acrobatic feat which lasts from one to four seconds, during which time they go through all kinds of contortions, frequently throwing themselves clear of the surface upon which they have been placed. Just how this is accomplished is not definitely known, as it is done almost too quickly for the eye to follow. However, they appear to bear down with the head and posterior end of the body at the same time, with such force that the impact throws them into the air. On account of this skipping habit the larvæ are frequently but erroneously termed "skippers."

That the larvæ are resistant to rough treatment is indicated by the following ordeal through which one was put by the junior author in an effort to photograph it. It was chloroformed for 15 minutes and, being then still somewhat active, was put into 80 per cent alcohol for 15 minutes more. The next morning it had revived and, except for a loss in the brillancy of its coloring due perhaps to its enforced fast, was as active as before.

The larvæ in all stages spin a silken thread wherever they go, and the younger ones readily suspend themselves by it.

LENGTH OF PUPAL STAGE.

The length of the pupal stage varies considerably, as will be seen from Table VII, temperature conditions having a great effect upon the length of this stage. This stage varies from 7 to 11 days in July, from 7 to 10 days in August, from 8 to 18 days in September and October, and from 19 to 21 days in October and November. The general average from the records of Table VII is 10.16 + days.

It should be stated that the records obtained during the fall of the year are approximate, as it has been found that the larvæ, upon entering the pupation tubes, sometimes do not transform immediately.

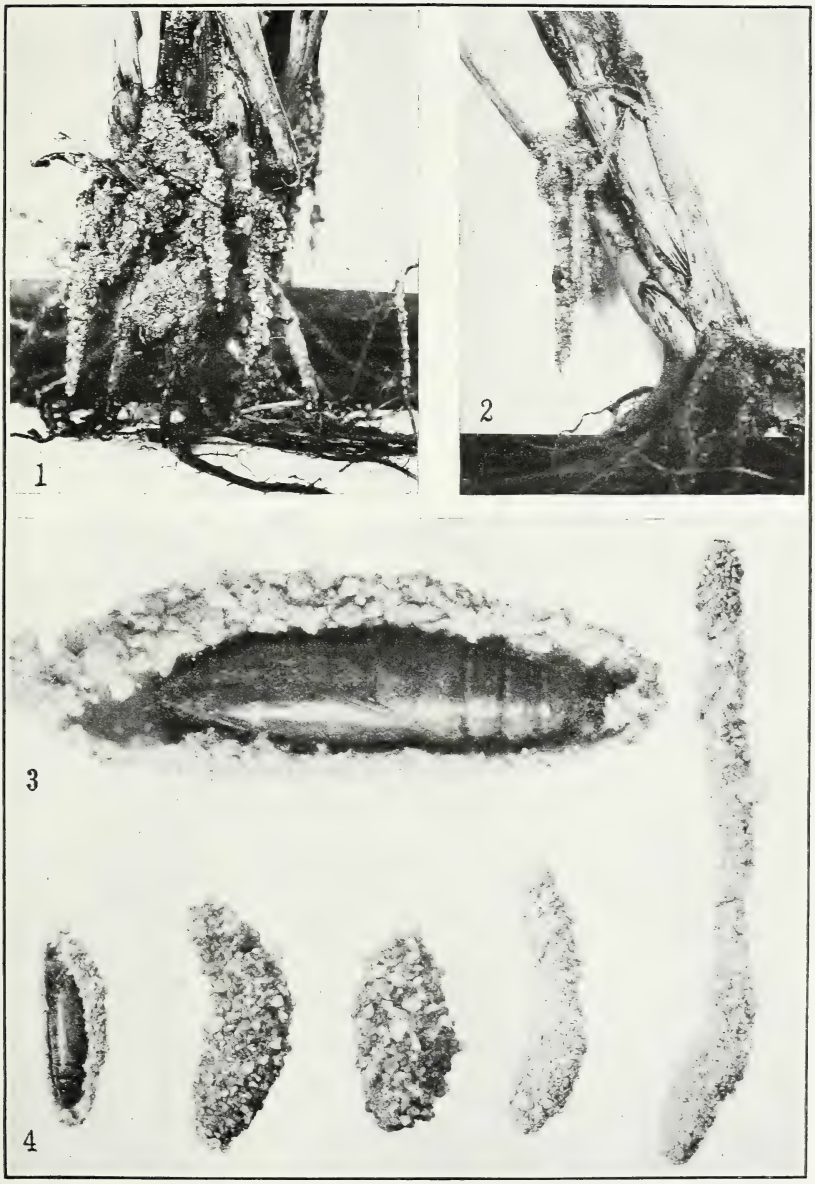
TABLE VII.—*Length of pupal stage of Elasmopalpus lignosellus. Records obtained at Columbia, S. C., in 1915.*

Number of individuals.	Date of—		Days.	Sex.	
	Pupation.	Emergence.			
	1913.	1913.			
1	Sept. 29	Oct. 16	17	.....	Male.
1	Sept. 30	...do....	16	Female....	
	1914.	1914.			
2	July 8	July 17	9	...do.....	Do.
1	July 9	...do....	8	...do.....	
1	...do....	July 18	9	.....	
1	...do....	July 20	11	.....	
4	July 11	...do....	9	2 females..	1 male.
1	July 12	...do....	8	Female....	
1	July 13	July 21	8	...do.....	
1	...do....	July 20	7	.....	
	1915.	1915.			
1	Aug. 16	Aug. 25	9	.....	Male.
1	Aug. 17	...do....	8	Female....	
1	Aug. 18	Aug. 27	9	.....	Do.
1	...do....	Aug. 28	10	.....	Do.
1	Aug. 20	...do....	8	Female....	
1	...do....	Aug. 30	10	.....	Do.
1	Aug. 21	Aug. 28	7	.....	Do.
1	...do....	Aug. 29	8	.....	Do.
1	...do....	Aug. 30	9	.....	Do.
1	...do....	Aug. 31	10	.....	Do.
2	Aug. 23	...do....	8	Female....	Do.
3	Aug. 29	Sept. 6	8	2 females..	1 male.
1	...do....	Sept. 7	9	Female....	
1	...do....	Sept. 9	11	.....	Male.
1	Aug. 30	Sept. 7	8	Female....	
1	Sept. 24	Oct. 4	10	.....	Do.
1	Sept. 25	Oct. 6	11	.....	Do.
1	...do....	Oct. 9	14	Female....	
1	Sept. 27	Oct. 7	10	.....	Do.
1	Sept. 28	Oct. 6	8	.....	Do.
1	...do....	Oct. 7	9	.....	Do.
2	...do....	Oct. 9	11	Female....	Do.
1	...do....	Oct. 12	14	...do.....	
1	...do....	Oct. 14	16	...do.....	
1	...do....	Oct. 15	17	...do.....	
1	Sept. 29	...do....	16	...do.....	
1	Sept. 30	Oct. 16	16	...do.....	
2	Oct. 1	...do....	15	...do.....	Do.
1	Oct. 4	Oct. 18	14	...do.....	Do.
1	Oct. 6	...do....	12	...do.....	
1	Oct. 7	Oct. 19	12	...do.....	
1	...do....	Oct. 20	13	...do.....	
1	...do....	Oct. 23	16	...do.....	
1	...do....	Oct. 25	18	...do.....	
1	...do....	Oct. 28	21	...do.....	
1	Oct. 13	Nov. 1	19	.....	Do.
1	...do....	Nov. 8	26	Female....	
1	Oct. 18	...do....	21	...do.....	
2	Oct. 20	Nov. 10	21	2 females..	
59	.....	.....	10.16+		

Average length of pupal stage, 10.16+ days.
Maximum length of pupal stage, 21 days.
Minimum length of pupal stage, 7 days.

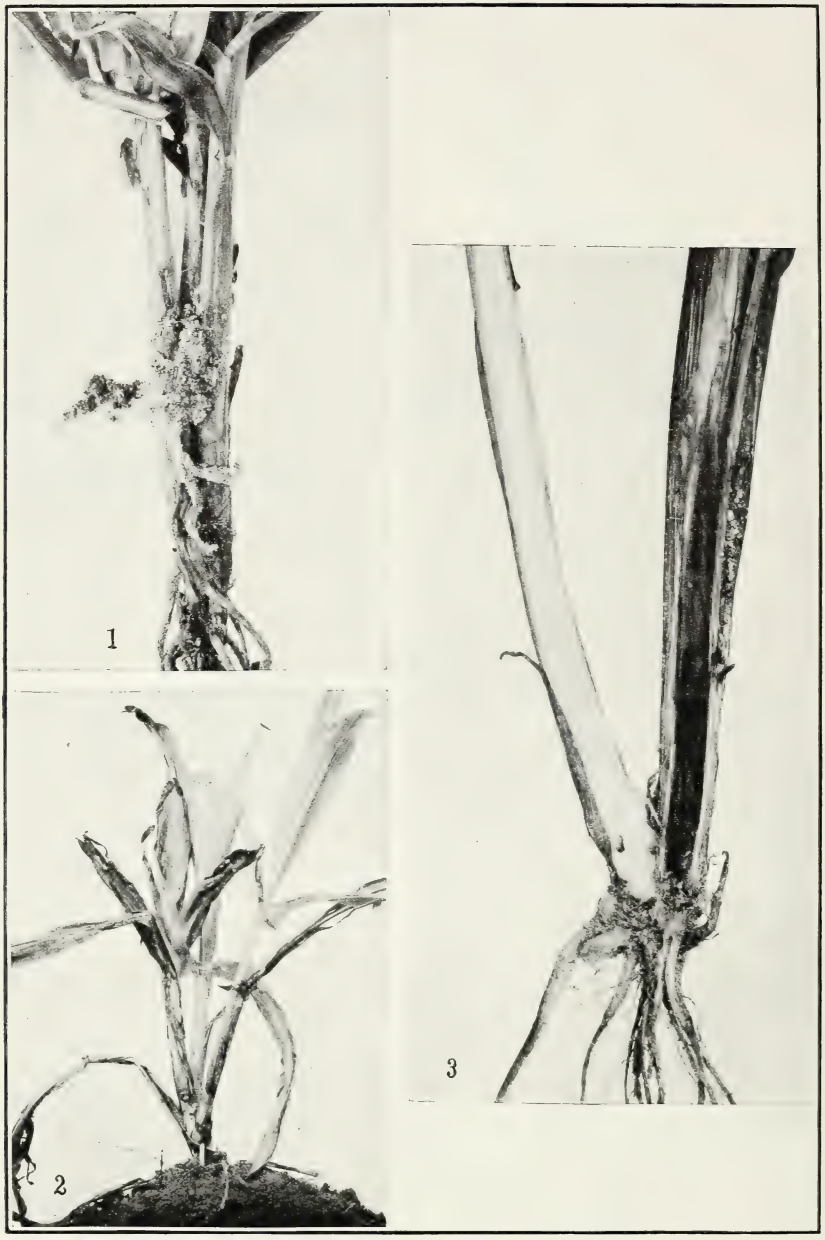
MATING.

Moths of this species usually mate the second day after emergence from pupæ in the summer time, and in the fall this period is somewhat lengthened. Mating probably takes place at night, although the moths have never been seen in coitu. A pair were found in copula in a cage in the morning and upon examination it was discovered that they were unable to disconnect themselves.



FEEDING TUBES AND COCOONS OF THE LESSER CORN STALK-BORER.

FIGS. 1, 2.—Feeding tubes attached at entrance to tunnels, at base of sorghum stalks. FIG. 3.—Cocoon opened, showing pupa *in situ*. FIG. 4.—Cocoons, with and without exit tubes. (Original.)



DAMAGE TO SORGHUM BY THE LESSER CORN STALK-BORER.

FIG. 1.—The many-branched feeding tube attached at entrance to tunnel, at base of sorghum stalk. FIG. 2.—Sorghum severely damaged by stalk-borers, as shown by the dead bud leaves. FIG. 3.—Stem sectioned to show the borer tunnel within. (Original.)

ACTIVITY OF THE MOTHS.

The moths are very active during the night. They are positively phototrophic to bright light and even react positively to diffused light. This probably accounts for the fact that copulation and oviposition were not observed, for as soon as cages were placed in light sufficient for observation the moths became restless and began to roam around in the cages.

LENGTH OF LIFE OF ADULTS.

The length of life of the adults of this species varied from five to eighteen days in the rearing cages, as is shown in Table VIII. The average duration of this period is approximately the same in both sexes. Adult moths confined in cages and supplied with food (sugar sirup) lived longer than when deprived of it.

TABLE VIII.—*Length of life of moths of Elasmopalpus lignosellus, at Columbia, S. C.*

Male.				Female.			
No.	Emerged.	Died.	Days.	No.	Emerged.	Died.	Days.
1	June 15	July 3	18	1	June 15	July 3	18
2	July 17	July 27	10	2	July 17	July 27	10
3	July 17	July 27	10	3	July 17	July 28	11
4	July 19	July 28	9	4	Aug. 22	Sept. 9	18
5	Aug. 30	Sept. 13	14	5	Aug. 30	Sept. 13	14
6	Aug. 30	Sept. 16	17	6	Aug. 30	Sept. 12	13
7	July 17	July 24	7	7	Sept. 10	Sept. 15	5
Average			12.1	Average			12.7

POLYGAMY.

Experiments were conducted to ascertain whether polygamy exists among the moths of this species. The moths that were used in these experiments emerged from pupæ which had been placed in individual tin boxes, and there was absolutely no chance of their having mated upon issuing, before being placed in the rearing cages.[1]

The male, after the death of the female (Cage 15–1113) with whom he had mated and from whom 134 eggs were obtained, was placed with a freshly issued female (Cage 15–1117). From this female 91 eggs were obtained. All of the eggs that were obtained in both of these cages were fertile.

In another cage, the male, which had mated with a female (Cage 15–1114) and from whom 192 fertile eggs resulted, was placed (Cage 15–1116) with a virgin female. From this female 194 fertile eggs were obtained.

[1] All of these cages are recorded in Table III.

LIFE CYCLE.

The life cycles of the generations (Table IX) during summer are considerably shorter than those of the fall of the year and possibly shorter than that of the spring generation. The spring generation has not been reared but probably has about the same cycle as the fall generation. They are about as follows:

TABLE X.—*Duration of the spring and fall generations of Elasmopalpus lignosellus at Columbia, S. C.*

Period or stage.	Summer broods.	Fall broods.
	Days.	*Days.*
Time elapsing between emergence and oviposition	2	2.5
Egg stage	3.5	5.6
Larval stage	24	36
Pupal stage	9	21
Total	38.5	64.6

By comparing the two cycles it will be noticed that the time required for the insect to pass through the cycle during the summer months is only about 6.2 days more than one-half of the time required in the fall of the year.

NUMBER OF GENERATIONS.

There are probably four generations of this species in the latitude of Columbia, S. C., although it has not been reared continuously for one whole year to verify this. However, three complete generations were reared from the middle of June to the middle of October in 1913.

Some of the pupæ of the last generation gave rise to moths, while the remainder died during the winter. Some of the larvæ of this last generation, not pupating in the fall, died also during the winter, apparently from the lack of suitable food and from being kept under abnormal conditions. Otherwise they possibly would have completed their growth, pupated, and given rise to moths early in the following spring (1914).

Our collection in the spring of 1915 would seem to substantiate this. Larvæ nearly full grown were found for the first time on corn in the field during the first week in June, thus rendering it probable that the eggs producing these larvæ were placed when the corn was up, by the moths issuing from pupæ in the early spring, as the field in which they were found was winter plowed and freed from rubbish and grass, making it impossible for these larvæ to have wintered over under these conditions.

WINTERING.

In the latitude of Columbia, S. C., this species apparently passes the first part of the winter as a larva and the latter part as a pupa and possibly adult, although it has not been possible to verify this absolutely by rearing experiments.

Larvæ have been found in the field, in their burrows in the stalks, as late as the middle of November, after which time none could be found. Repeated efforts were made at various times during winter to find pupæ, and one cocoon containing a pupa was found in January which, unfortunately, died. This pupa probably would have changed early in the spring to an adult.

According to the experiments of the writers in 1915, larvæ pupating in the fall did not winter as such but gave rise to moths in early winter. These moths died within a short time, which circumstance would seem to indicate that this species does not winter in the adult stage. Larvæ have been kept alive in rearing cages under outdoor conditions up to January, at which time they died, apparently from being kept in closed receptacles, which was very favorable for the development of a fungus which killed them.

In Arizona the species probably passes the winter in the larval stage, judging from the fact that larvæ in all sizes were found as late as November 3 at Tempe, Ariz.

REARING METHODS.

In rearing the larvæ of this species a number of different types of cages were used, such as the ordinary "pot cage" surmounted by a lantern chimney covered with cheesecloth, or with a celluloid cylinder covered with cheesecloth. None of these types of cages gave complete satisfaction, for the reason that they could not be made tight enough and the larvæ, being very restless, are ever on the alert to find an opening through which they may escape.

Tin salve boxes and the ordinary low-type jelly glass with tin cover proved the most satisfactory of all cages. In rearing these larvæ, a small quantity of sand was placed in the bottom of each and kept moistened. These containers were kept supplied with fresh cowpea leaves and a number of larvæ were reared in each receptacle.

To obtain eggs, a cage, consisting of a 6-inch flowerpot saucer, lantern chimney covered with cheesecloth, and a bottle containing a small sorghum plant, in water, was employed with success.

In making a study of the different instars, small test tubes, used in bacteriological experiments, were found to be the most practical, on account of the convenient size and also because observations could be made without removing specimens.

NATURAL ENEMIES.

According to observations, the lesser corn stalk-borer apparently suffers very little from natural enemies. This condition is undoubtedly a result of the excellent protection afforded the larvæ at all times, both while feeding in their burrows and while resting in their tubes. One parasite, a hymenopteron, determined as *Neopristomerus* sp., has been reared in the laboratory at Columbia, S. C. This parasite emerged September 1, 1914, from a larva collected at Columbia, S. C.

Another parasite was reared by R. N. Wilson at Gainesville, Fla., September 11, 1916, which was determined by Mr. A. B. Gahan as *Orgilus laeviventris* Cress. Mr. Gahan believes it probable that the parasite of *Elasmopalpus lignosellus* recorded by Chittenden (18) as *Orgilus mellipes* Say was in reality *laeviventris*.

METHODS OF CONTROL.

The ravages of this insect can be reduced markedly if not entirely controlled by progressive methods of farming. Infested fields should be plowed very late in fall or early winter, after they have been freed from all remnants and waste material. The borders and terraces of the field should be gone over with a harrow to stir up the ground. This breaks up the winter quarters of pupæ and causes them to perish.

The practice of cleaning up and working these waste places is not only an excellent one for the eradication of this species but also contributes to the destruction of many other noxious insects that chance to be hibernating therein; and as usually very little attention is given to the practice of clean cultural methods and the cleaning up of such waste places, the importance of such methods can not be overemphasized.

In regions where this insect remains more or less active throughout the winter, it is advisable to plow out and destroy the infested stubble in case of corn, sorghum, etc. In all other cases fall plowing and thorough working of the ground are to be recommended.

It is also of great importance that the sandy areas of the fields be made as rich as possible. A thorough application of fertilizer should be made in order to stimulate plant growth and make the plants more resistant to the attacks of this insect.

Where it is necessary to plant corn, sorghum, and allied crops in fields subject to infestation, it is advisable to make such plantings as early in the season as possible, thus enabling the plants to get a good start before the insect begins its depredations.

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